Combustion waves with thermal losses in porous media

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There is renewed interest using combustion for the recovery of medium viscosity oil. We consider the combustion process when air in injected into the porous medium containing some fuel and inert gas to enable the combustion of oil and other consecutive reactions within the reservoir formation leading to the release of heat. Heat is conducted ahead of the combustion front, reduces the oil viscosity and enhancing flow.

In this work one dimensional gas-solid combustion is studied with the combustion rate described by the first order mass action law combined with the Arrhenius' law. We consider a cylindrical porous rock containing solid fuel. Standard simplifications are made in order to formulate the physical model, for example, the gas thermal capacity is considered small. Commonly the thermall losses are neglected for mathematical analysis and numerical simulations. For applications in the field and laboratory experiments this assumption may fail due to lack of thermal insulation.

In previous works [1, 4] models without thermall losses were analized and combustion wave profile was obtained using different techniques. Different numerical aproachs were used, see [2, 3] and evidences of the existence of stable solution in the form of traveling wave were obtained.

In this work we analize the model taking into account the thermall losses. We solve the correponding Riemann problem and obtain the solution as wave sequence. In the particular case the existence and stability of the combustion wave will be shown. Numerical simulations were performed in order to validate the analitical results.

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